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Contents

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Surveillance Trends

Heat-related Illnesses Among Active Duty Soldiers and Marines, 1997-1999

Heat-related illnesses occur in previously healthy young adults as a consequence of prolonged exertion in the heat. Military servicemembers are particularly vulnerable to heat-related illnesses because they often perform strenuous work under heat stressful conditions.[1-7]

The US Army Institute of Environmental Medicine has developed guidelines for work-rest cycles and fluid replacement volumes during work in heat-stressful conditions (table 1). The guidelines were designed to maximize work capacity while minimizing the risk of heat-related illness. This report discusses risk factors associated with, and summarizes recent experiences regarding, heat-related illnesses among active duty servicemembers.

Methods. The Defense Medical Surveillance System was queried to identify all heat-related (ICD-9-CM code: 992) hospitalizations and ambulatory visits of active duty servicemembers between January 1997 and October 1999. Only incident cases were used for the analysis. An incident case of a heat-related illness was defined as the first hospitalization or ambulatory visit of a servicemember during the study period or the first hospitalization or ambulatory visit at least 90 days after a prior incident visit.

The Health Risk Appraisal (HRA) is a questionnaire administered to soldiers and their families to assess their behavioral risks. All HRAs completed by cases (servicemembers with heat-related illnesses) and non-cases during the study period were identified.

When a servicemember had multiple HRAs during the study period, only the HRA closest to the date of the event for cases or the latest for non-cases was used for analysis. Responses to questions relating to physical stature (height, weight, and frame size), physical activity, diet, sleeping, drinking, and smoking were the variables of interest.

Results. Between January 1997 and October 1999, there were 4,093 incident heat-related illnesses among active duty servicemembers. Of the total, 3,386 or 83% occurred among Army or Marine Corps servicemembers. Since soldiers and Marines were most affected, further analyses considered only cases from these two Services.

Of all heat-related illnesses among soldiers and Marines, 56% were reported as "heat exhaustion," 12% as "heat stroke," 10% as "heat cramps," and 3% as "syncope." The remaining approximately 19% of cases had nonspecific diagnoses.

*Seasonal and annual trend*s. In both Services in each year, case frequencies were relatively low in late fall and winter (November-April), high in summer

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Table 1. Fluid replacement policy for warm weather training
(Average acclimated soldier wearing battle dress uniform, hot weather)

		Easy Work		Moderate Work		Hard Work	
Heat category	WBGT Index, °F	Work/rest (min.)	Water intake (qt/hr)	Work/rest (min.)	Water intake (qt/hr)	Work/rest (min.)	Water intake (qt/hr)
1	78 - 81.9	NL*	½	NL*	¾	40/20	¾
2	82 - 84.9	NL*	½	50/10	¾	30/30	1
3	85 - 87.9	NL*	¾	40/20	¾	30/30	1
4	88 - 89.9	NL*	¾	30/30	¾	20/40	1
5	> 90	50/10	1	20/40	1	10/50	1

* NL: no limit to work time per hour.
Note: The work/rest times and fluid replacement volumes will sustain performance and hydration for at least 4 hours of work in the specified heat category. Rest means minimal physical activity (e.g., sitting or standing) and should be accomplished in shade if possible. Individual water needs will vary by up to ¼ quart per hour. MOPP gear adds 10oF to WBGT index.

Caution: Hourly fluid intake should not exceed 1½ quarts.
Daily fluid intake should not exceed 12 quarts.

Figure 1. Heat-related illnesses by month, active duty US Army, 1997-1999

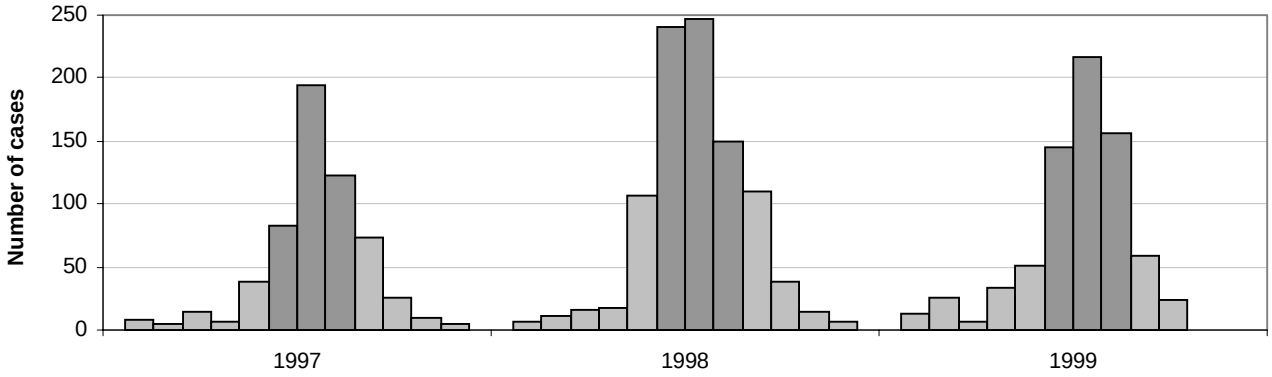


Figure 2. Heat-related illnesses by month, active duty Marines, 1997-1999

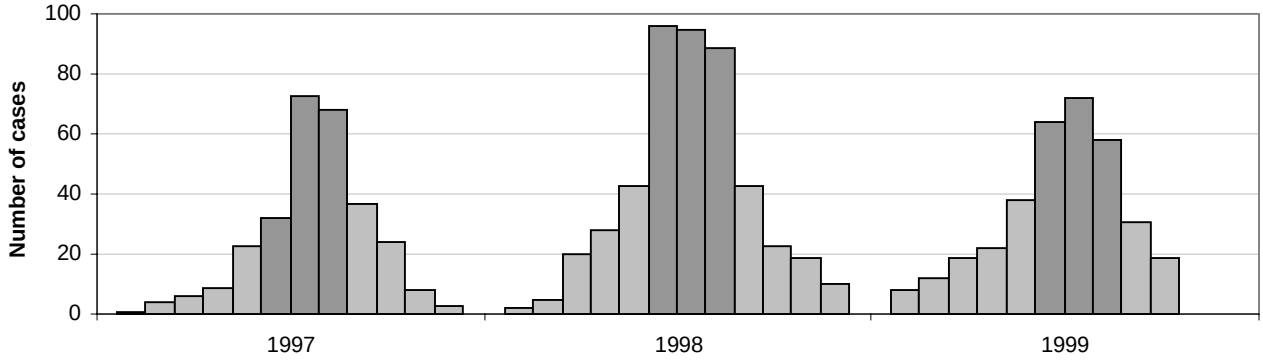


Table I. Sentinel reportable events, US Army medical treatment facilities[1] Cumulative events for all beneficiaries, calendar year through February 28, 1999 and 2000[2]

Reporting facility	Number of reported events[3]		Environmental				Food- and Water-borne							
			Cold		Heat		Campylobacter		Giardia		Salmonella		Shigella	
	Cum. 1999	Cum. 2000	Cum. 1999	Cum. 2000	Cum. 1999	Cum. 2000	Cum. 1999	Cum. 2000	Cum. 1999	Cum. 2000	Cum. 1999	Cum. 2000	Cum. 1999	Cum. 2000
NORTH ATLANTIC RMC														
Walter Reed AMC, DC	51	36	-	-	-	-	1	-	-	-	-	1	-	-
Aberdeen Prov. Grd., MD	9	-	-	-	-	-	-	-	-	-	-	-	-	-
FT Belvoir, VA	27	33	-	-	-	-	1	1	1	-	1	-	-	-
FT Bragg, NC	148	195	2	-	1	-	1	-	-	-	1	-	-	-
FT Drum, NY	25	38	6	9	-	-	-	-	-	-	-	-	-	-
FT Eustis, VA	40	21	-	-	-	-	-	-	-	-	-	-	-	-
FT Knox, KY	33	41	-	-	-	-	-	-	-	-	1	-	-	-
FT Lee, VA	34	34	-	-	-	-	-	-	-	-	-	-	-	-
FT Meade, MD	4	20	-	-	-	-	-	-	-	-	-	1	-	-
West Point, NY	3	6	-	-	-	-	-	-	-	-	-	-	-	-
GREAT PLAINS RMC														
Beaumont AMC, TX	-	34	-	-	-	-	-	-	-	-	-	-	-	-
Brooke AMC, TX	126	74	-	-	-	-	-	-	-	-	1	-	4	1
FT Carson, CO	83	116	-	-	-	-	-	-	-	-	-	-	-	-
FT Hood, TX	81	183	-	1	-	-	-	1	-	-	-	-	-	2
FT Huachuca, AZ	-	6	-	-	-	-	-	-	-	-	-	-	-	-
FT Leavenworth, KS	-	2	-	-	-	-	-	-	-	-	-	-	-	-
FT Leonard Wood, MO	32	27	1	3	-	-	-	-	-	-	-	-	-	-
FT Polk, LA	18	35	-	-	-	-	-	-	-	-	-	-	-	-
FT Riley, KS	29	71	-	19	-	-	-	-	-	-	-	-	-	-
FT Sill, OK	59	-	-	-	-	-	-	-	-	-	-	-	-	-
SOUTHEAST RMC														
Eisenhower AMC, GA	44	40	1	-	-	-	-	-	-	-	-	-	-	-
FT Benning, GA	62	33	-	-	9	-	-	-	-	-	-	-	-	-
FT Campbell, KY	78	74	-	2	-	-	5	-	-	2	3	-	2	4
FT Jackson, SC	78	-	-	-	-	-	-	-	-	-	-	-	-	-
FT Rucker, AL	5	14	-	-	-	-	-	-	-	-	-	-	-	-
FT Stewart, GA	63	97	-	-	-	-	-	-	-	-	1	-	-	-
WESTERN RMC														
Madigan AMC, WA	110	117	-	-	-	-	-	-	-	-	2	-	-	1
FT Irwin, CA	-	2	-	-	-	-	-	-	-	-	-	-	-	-
FT Wainwright, AK	16	3	9	2	-	-	-	-	-	-	-	-	-	-
OTHER LOCATIONS														
Tripler, HI	71	114	-	-	-	-	3	5	4	5	1	1	-	-
Europe	66	51	1	1	-	-	2	-	-	-	1	2	-	-
Korea	13	79	7	2	-	-	-	-	-	-	-	1	-	-
Total	**1408**	**1596**	**27**	**39**	**10**	**-**	**13**	**7**	**5**	**7**	**12**	**6**	**6**	**8**

1. Main and satellite clinics.
2. Events reported by March 7, 1999 and 2000.
3. Tri-Service Reportable Events, Version 1.0, July 1999.

Table I. (Cont'd) Sentinel reportable events, US Army medical treatment facilities[1] Cumulative events for all beneficiaries, calendar year through February 28, 1999 and 2000[2]

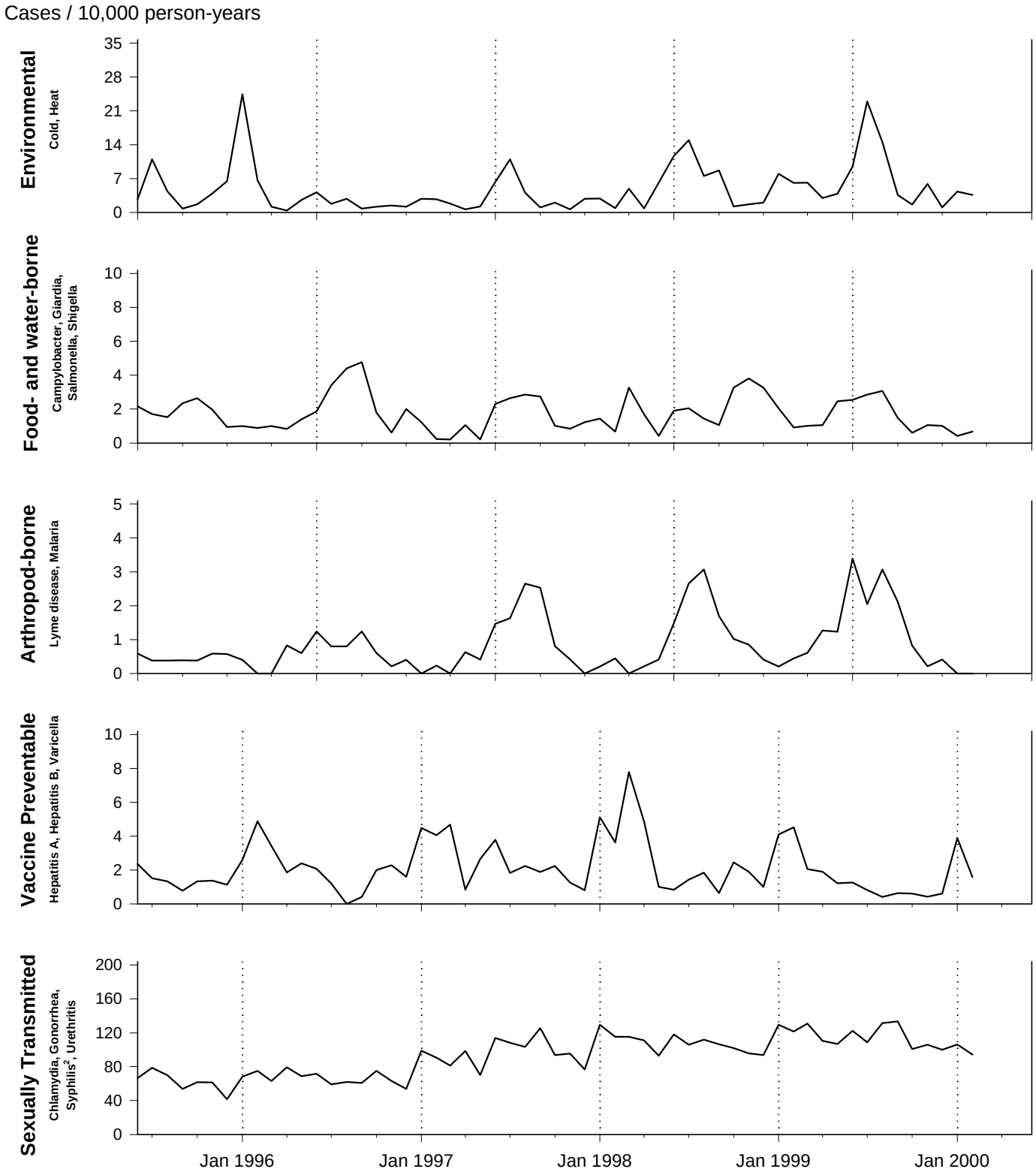
Arthropod-borne				Vaccine Preventable						Sexually Transmitted							
Lyme Disease		Malaria		Hepatitis A		Hepatitis B		Varicella		Chlamydia		Gonorrhea		Syphilis[4]		Urethritis	
Cum. 1999	Cum. 2000	Cum. 1999	Cum. 2000	Cum. 1999	Cum. 2000	Cum. 1999	Cum. 2000	Cum. 1999	Cum. 2000	Cum. 1999	Cum. 2000	Cum. 1999	Cum. 2000	Cum. 1999	Cum. 2000	Cum. 1999	Cum. 2000
1	-	1	-	-	-	-	-	2	2	18	5	3	4	-	1	1	-
-	-	-	-	-	-	-	-	1	-	1	-	5	-	-	-	2	-
-	-	-	-	-	-	-	-	-	-	17	27	7	3	-	-	-	-
-	-	-	1	-	-	-	-	1	1	96	78	46	52	-	-	-	62
-	-	1	-	-	-	-	-	3	-	9	21	6	8	-	-	-	-
-	-	-	-	-	-	-	1	1	-	29	13	9	6	-	-	-	-
-	-	-	-	-	-	-	1	-	2	18	29	13	7	-	1	-	-
-	-	-	-	-	-	-	-	-	-	23	26	10	8	1	-	-	-
-	-	-	-	-	-	-	-	-	-	3	15	-	2	-	-	-	-
-	-	-	-	-	-	-	-	1	-	2	6	-	-	-	-	-	-
-	-	-	-	-	1	-	-	-	-	-	23	-	9	-	-	-	-
-	-	-	-	-	-	2	-	2	2	25	27	17	10	-	-	1	-
-	-	-	-	-	-	-	-	-	-	64	92	7	19	-	-	12	4
-	-	-	-	-	-	1	-	-	2	45	96	21	36	1	-	13	25
-	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
-	-	-	-	-	-	1	-	3	7	16	1-	6	5	1	-	1	2
-	-	-	-	-	-	-	-	-	-	13	33	5	2	-	-	-	-
-	-	-	-	-	-	-	-	-	-	21	36	8	16	-	-	-	-
-	-	-	-	-	-	-	-	5	-	28	-	18	-	-	-	7	-
-	-	-	-	-	-	-	-	-	1	41	36	1	2	-	-	-	-
-	-	-	-	1	-	-	-	-	5	19	19	26	6	1	2	-	-
-	-	1	-	-	-	-	-	-	1	47	35	20	25	-	1	-	-
-	-	-	-	-	-	-	-	1	-	69	-	7	-	1	-	-	-
-	-	-	-	-	-	-	-	-	-	4	10	1	4	-	-	-	-
-	-	-	-	-	-	-	-	4	-	22	34	12	23	-	-	24	40
-	-	-	-	-	-	-	-	-	-	75	70	12	12	-	-	18	27
-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	5	1	2	-	-	-	-	-
-	-	1	-	-	1	-	1	-	-	32	67	17	11	-	-	-	-
-	-	1	-	-	-	2	-	1	2	48	36	9	6	-	-	-	-
-	-	-	-	-	-	1	1	-	1	5	63	-	2	-	6	-	-
1	**-**	**5**	**1**	**1**	**2**	**7**	**4**	**25**	**26**	**795**	**914**	**288**	**281**	**5**	**11**	**79**	**160**

4. Primary and Secondary

Note: Completeness and timeliness of reporting varies by facility.

Source: Army Reportable Medical Events System.

Figure I. Sentinel reportable events (grouped), active duty soldiers, June 1995-February 2000[1]



1. Events reported by March 7, 2000
2. Primary and Secondary

Source: Army Reportable Medical Events System

Table 2. Heat-related illnesses, by gender, ethnicity, age, and grade, US Army and Marine Corps, 1997-1999

Characteristics	Army				Marine Corps				Total	
	Females		Males		Females		Males			
	Incident Cases	Cases per 1,000 person-years	Incident Cases	Cases per 1,000 person-years	Incident Cases	Cases per 1,000 person-years	Incident Cases	Cases per 1,000 person-years	Incident Cases	Cases per 1,000 person-years
Total	428	2.0	1854	1.5	125	4.4	979	2.0	3386	1.7
Race/ethnicity										
Asian/Pacific Islander	8	1.3	66	2.1	6	7.7	40	4.0	120	2.5
Black	181	2.0	403	1.4	35	5.3	174	2.3	793	1.7
Hispanic	32	2.5	136	1.6	13	3.6	96	1.8	277	1.8
Native American	9	4.5	15	1.8	1	2.3	11	2.5	36	2.4
White	185	2.0	1192	1.6	69	4.1	645	1.9	69	1.3
Other/unknown	13	1.9	42	1.1	1	1.9	13	1.9	2091	1.7
Age										
< 20	75	2.6	261	2.0	50	6.9	319	3.3	705	2.7
20-24	167	2.5	755	2.1	56	4.8	442	2.1	1420	2.2
25-29	97	2.0	490	1.8	9	2.0	134	1.8	730	1.8
30-34	44	1.4	225	1.1	7	2.9	45	1.0	321	1.1
35-39	29	1.3	80	0.5	3	1.5	21	0.6	133	0.6
40 +	16	1.1	43	0.4	0	0.0	18	0.8	77	0.6
Grade										
E1-E4	313	2.7	1228	2.2	98	5.2	804	2.6	2443	2.4
E5-E9	86	1.3	423	0.9	25	3.4	134	1.0	668	1.0
O1-O3, W1-W3	25	1.2	183	1.5	2	1.1	34	1.1	244	1.4
O4-O9, W4-W5	4	0.4	20	0.3	0	0.0	7	0.4	31	0.3

continued from page 3

(June-August), and intermediate in late spring (April-May) and early fall (September-October). For both Services, there were approximately two-thirds more cases in 1998 compared to 1997 (1998-to-1997 frequency ratios: Army: 1.65; Marine Corps: 1.64) and approximately one-fourth fewer cases in 1999 compared to 1998 (1999-to-1998 frequency ratios: Army: 0.76; Marine Corps: 0.73) (figures 1 and 2, page 3).

Locations. Nearly three-fourths (73%) of cases occurred in six Southern and Southeastern states. Four Army bases (Benning, GA; Bragg, NC; Campbell, KY; and Polk, LA) and three Marine installations (Lejeune, NC; Parris Island, SC; and Pendleton, CA) accounted for the majority of all cases.

Demographics (table 2). Heat-related illness rates were higher among females than males. Relative to their male counterparts, females had higher risk in the Marine Corps (female-to-male rate ratio: 2.2) than in the Army (female-to-male rate ratio: 1.3).

Soldiers and Marines who were Asian or Native American and those who were younger than 25 had higher heat-illness rates than their counterparts. Enlisted servicemembers (particularly infantrymen, basic trainees/recruits, and those in the lowest grades) had much higher heat-illness rates than officers.

Health Risk Appraisals (Army only). HRA responses were available for 992 (45%) of the 2,282 heat-related cases among soldiers. A higher percentage of cases than noncases reported sleeping less than 5 hours a night, eating high fat foods at every meal, eating high sodium foods at every meal, and ever having a drinking problem. One of the more common predictors, Body Mass Index (BMI), was not significantly associated with heat-related illness (table 3, page 8).

Editorial comment. Heat stroke is the most serious of heat-related illnesses. When the body generates

more heat than it is able to dissipate, heat accumulates, the body's core temperature rises, and potentially widespread physiologic dysfunction occurs.

Rapid treatment of heat stoke is critical since the longer the body's core temperature is elevated, the greater the risks of severe organ damage and death.[1] Signs and symptoms of heat stroke include hot dry skin, marked elevation of body temperature (≥105.0 F.), disorientation, delirium, and coma.

Heat exhaustion is less severe than heat stroke but more common. It generally occurs from persistent or recurrent exposures to high temperatures over periods of several days with inadequate or unbalanced replacements of fluids and electrolytes. The symptoms of heat exhaustion generally include dizziness, weakness, and fatigue.[2]

Sweat evaporation is the most important mechanism of heat dissipation.[3] Common factors that inhibit the production or evaporation of sweat include decreased physical fitness, excess body weight, hypohydration, lack of sleep, the effects of alcohol and many over-the-counter and prescribed drugs, insulation from clothing and equipment, and humid environments.[1-7] Other factors decrease heat tolerance by increasing heat production. They include metabolic disorders, febrile illnesses, and exercise.[3] Finally, individuals who are not acclimatized to hot environments or who have had prior heat-related illnesses are at increased risk.

Factors that decrease heat tolerance and are modifiable continue to be the focus of military preventive medicine research, policies, and practices. Commanders and supervisors at all levels should enforce work/rest and fluid replacement practices that are consistent with current published guidelines (table 1, page 3).

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Table 3. HRA responses (selected) among heat-related cases and noncases, 1997-1999

Question	Response	Cases		Noncases	
		Number	Percent	Number	Percent
How many hours of sleep do you usually get at night?	5 or less	235	26.8%	83,088	20.5%
	6-8	636	72.4%	316,387	78.0%
	9+	7	0.8%	6,396	1.6%
How often do you eat foods high in saturated fats?	Every meal	65	7.3%	22,476	5.5%
	Daily	302	33.9%	137,971	33.6%
	3-5 days/week	270	30.3%	147,504	35.9%
	< 3 days/week	254	28.5%	102,891	25.0%
How often do you eat foods high in salt or sodium?	Daily	147	16.6%	59,154	14.4%
	3-5 days/week	279	31.4%	135,872	33.1%
	< 3 days/week	462	52.0%	215,685	52.5%
Have you ever had a drinking problem?	Yes	41	5.0%	14,721	4.2%
How often do you do at least 20 minutes of non-stop aerobic activity?	3+ days/week	627	70.1%	263,595	64.1%
	1-2 days/week	207	23.2%	114,930	28.0%
	Rarely/never	60	6.7%	32,619	7.9%
How often do you do exercises to improve muscle strength?	3+ days/week	738	82.7%	314,936	76.6%
	1-2 days/week	132	14.8%	82,314	14.8%
	Rarely/never	22	2.5%	13,683	3.3%
How would you describe your cigarette smoking habits?	Never smoked	536	60.3%	232,018	56.2%
	Current smoker	133	15.0%	61,984	15.0%
	Ex-smoker	220	24.8%	118,805	28.8%

Surveillance Trends

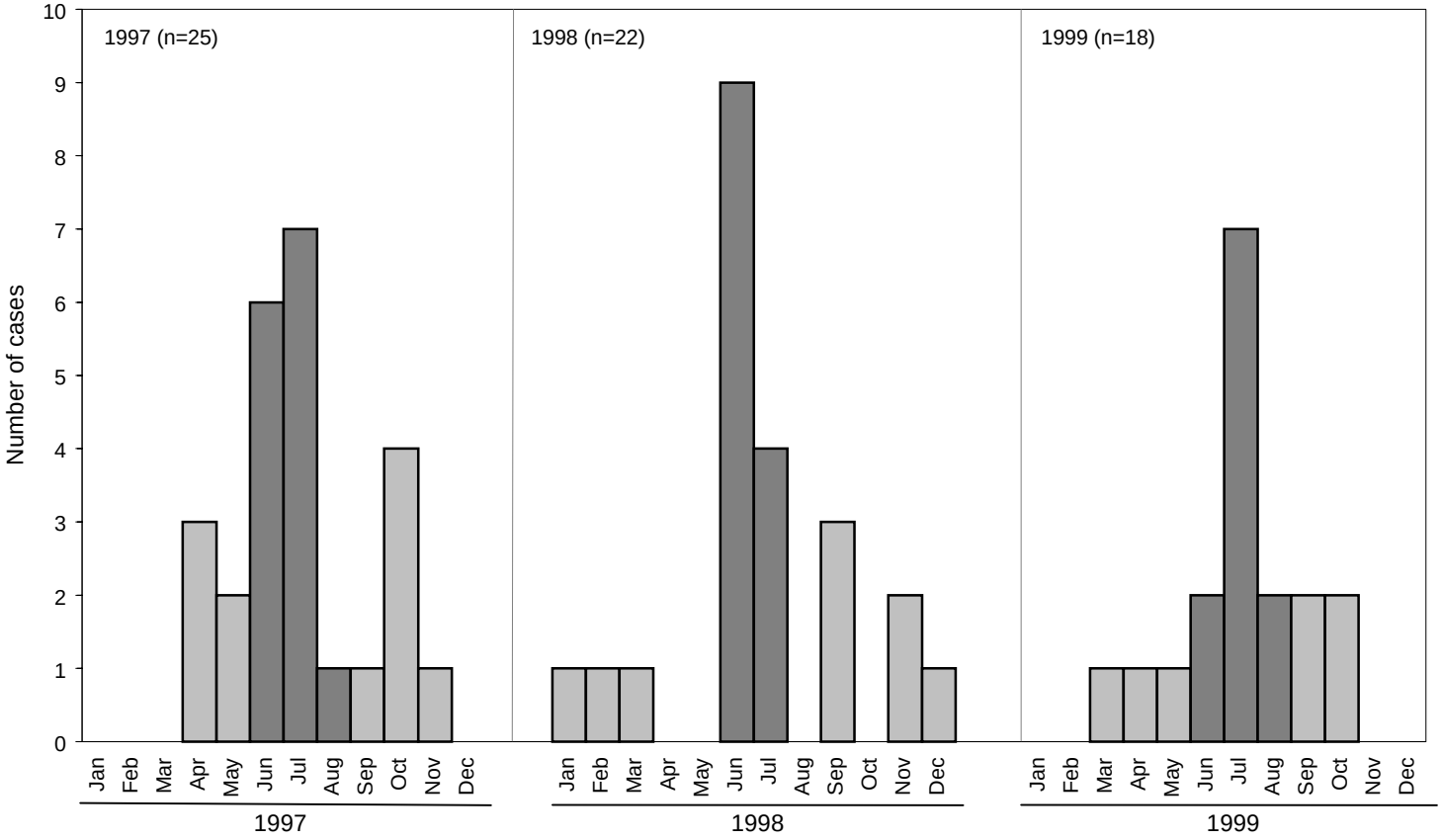
Overhydration and Hyponatremia Among Active Duty Soldiers, 1997-1999

In July 1997, five cases of hyponatremia secondary to heat stress and excessive water consumption, one of which was fatal, were reported among basic trainees at Fort Benning, Georgia.[1,2] A survey of other basic training posts documented additional episodes of this life-threatening heat-associated illness.[3] In April 1998, the Army revised its fluid replacement policy in order to lessen the risk of hyponatremia during military training in heat stressful conditions.[4,5] This summary extends previously published findings[6] of the surveillance of hyponatremia among soldiers.

Methods. For the period January 1997 through December 1999, all hospitalizations and unscheduled ambulatory visits of active duty soldiers were identified in which either: (a) the primary diagnosis was "hyposmolality and/or hyponatremia" (ICD-9-CM code: 276.1); or (b) the discharge diagnoses included both 276.1 and either "fluid overload" (ICD-9-CM code: 276.6) or "effects of heat" (ICD-9-CM codes: 992.0-992.9). For each individual, only the first hospitalization or ambulatory visit that met the surveillance case definition was maintained. Two cases were excluded from final analyses due to concurrent, possibly predisposing medical conditions (i.e., systemic lupus erythematosus, hypertension, and diuretic use; anemia secondary to acute blood loss). All data used in analyses were obtained from files of the Defense Medical Surveillance System.

Results (figure 1). From 1997 to 1999, there were 65 cases of hyponatremia among active duty soldiers. Two-thirds (n=43) of the cases were hospitalized. Two basic training posts (Fort Benning, Georgia,

Figure 1. Hyponatremia/hyposmolality cases, active duty soldiers, 1997-1999



with 17 cases and Fort Jackson, South Carolina, with 9 cases) accounted for 40% of cases (table 1).

Case frequencies and crude rates were approximately 12% lower in 1998 (n=22) and 28% lower in 1999 (n=18) compared to 1997 (n=25). However, while the case incidence declined by 90% at Fort Benning (1997, n=10; 1998, n=6; 1999, n=1), it remained relatively stable for the rest of the Army (1997, n=15; 1998, n=16; 1999, n=17).

During the period, crude rates were highest among the youngest (and lowest ranking) enlisted soldiers. In relation to race/ethnicity, rates were lowest among black non-Hispanic soldiers and highest among Hispanic and other ethnic minority soldiers. The proportions of males and females among cases reflected their proportions in the Army overall (table 2).

Editorial comment. The incidence of overhydration/hyponatremia among soldiers has declined in the two years since the Army promulgated new fluid replacement guidelines. Of note, however, the decline Armywide may be entirely attributed to the dramatic decline in incidence at Fort Benning. This should not be surprising. The recent attention[1-7] on water intoxication risk in the context of military training was initiated by a cluster of cases among trainees at Fort Benning. At the time, Fort Benning accounted for more than 40% of all Army cases. The rapid, multi-disciplinary response of Fort Benning—with the support of consultants from the US Army Institute of Environmental Medicine, the US Army Center for Health Promotion and Preventive Medicine, and other Army medical institutions—resulted in a comprehensive fluid replacement/heat casualty management plan that was quickly implemented. The subsequent declines in incidence at Fort Benning suggest that the plan and its implementation were effective.

In general, risks of overhydration/hyponatremia among active duty soldiers are highest in June and July among basic trainees. However, the most

Table 1. Overhydration and hyponatremia by facility, active duty soldiers, 1997-1999

Location	1997		1998		1999		Total	
	Cases	% of total	Cases	% of total	Cases	% of total	Cases	% of total
Ft. Benning, GA	10	(40.0)	6	(27.3)	1	(5.6)	17	(26.2)
Ft. Jackson, SC	4	(16.0)	1	(4.5)	4	(22.2)	9	(13.8)
Ft. Polk, LA	3	(12.0)	1	(4.5)	1	(5.6)	5	(7.7)
Ft. Story, VA	2	(8.0)	2	(9.1)	1	(5.6)	5	(7.7)
Ft. Bliss, TX	1	(4.0)	0	0	3	(16.7)	4	(6.2)
Ft. Gordon, GA	1	(4.0)	1	(9.1)	1	(5.6)	3	(4.6)
Ft. Bragg, NC	0	0.0	2	(9.1)	0	0	2	(3.1)
Ft. Knox, KY	2	(8.0)	0	0	0	0	2	(3.1)
Ft. Lewis, WA	0	0	1	(4.5)	1	(5.6)	2	(3.1)
Ft. Sill, OK	1	(4.0)	0	0	1	(5.6)	2	(3.1)
Ft. Stewart, GA	0	0	2	(9.1)	0	0	2	(3.1)
Ft. Wood, MO	1	(4.0)	1	(4.5)	0	0	2	(3.1)
Panama	0	0	2	(9.1)	0	0	2	(3.1)
Korea	0	0	0	0	2	(11.1)	2	(3.1)
Ft. Campbell, KY	0	0	1	(4.5)	0	0	1	(1.5)
Ft. Carson, CO	0	0	0	0	1	(5.6)	1	(1.5)
Ft. Hood, TX	0	0	0	0	1	(5.6)	1	(1.5)
Ft. Lee, VA	0	0	1	(4.5)	0	0	1	(1.5)
Ft. Riley, KS	0	0	1	(4.5)	0	0	1	(1.5)
Walter Reed, DC	0	0	0	0	1	(5.6)	1	(1.5)
Total	**25**		**22**		**18**		**65**	

Table 2. Overhydration and hyponatremia, by demographic characteristics, active duty soldiers, 1997-1999

Characteristics	Cases	% of total
Gender		
Female	10	(15.4)
Male	55	(84.6)
Race/ethnicity		
Asian/Pac Islander	2	(3.1)
Black	9	(13.8)
Hispanic	9	(13.8)
Native American	2	(3.1)
White	41	(63.1)
Other/unknown	2	(3.1)
Age		
<20	17	(26.2)
20-24	17	(26.2)
25-29	15	(22.9)
30-34	7	(10.8)
35-39	5	(7.7)
=>40	4	(6.2)
Grade		
E1-E2	29	(44.6)
E3-E4	17	(26.2)
E5-E6	11	(16.9)
E7-E9	4	(6.2)
Officers	4	(6.2)

significant heat-related threats to soldiers by far remain those associated with too little, rather than too much, water consumption. Current Army fluid replacement policy is designed to prevent both water intoxication risk and dehydration risks. Thus, to minimize casualties and training disruptions in hot weather, training personnel at all levels should enforce fluid replacement practices that conform to current policy guidelines. (See previous article, table 1, page 3.)

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Surveillance Trends

Five Most Common Arthropod-Borne Diseases Among Active Duty Servicemembers in the US Armed Forces, 1995 - 1999

Arthropod-borne diseases are ubiquitous threats to the health of military personnel and to operational effectiveness. Arthropod-borne diseases common to the tropics, such as malaria, dengue fever, and leishmaniasis, particularly threaten military personnel who are stationed in or deploy to Asia, Africa, Central and South America, and the Caribbean.[1-9] Other arthropod-borne diseases, such as Lyme disease and Rocky Mountain spotted fever (RMSF), are more common in temperate regions such as the United States and Europe.[10-11] This report summarizes rates, trends, and correlates of risk for the five most frequently diagnosed arthropod-borne diseases among members of the US Armed Forces over the last five years.

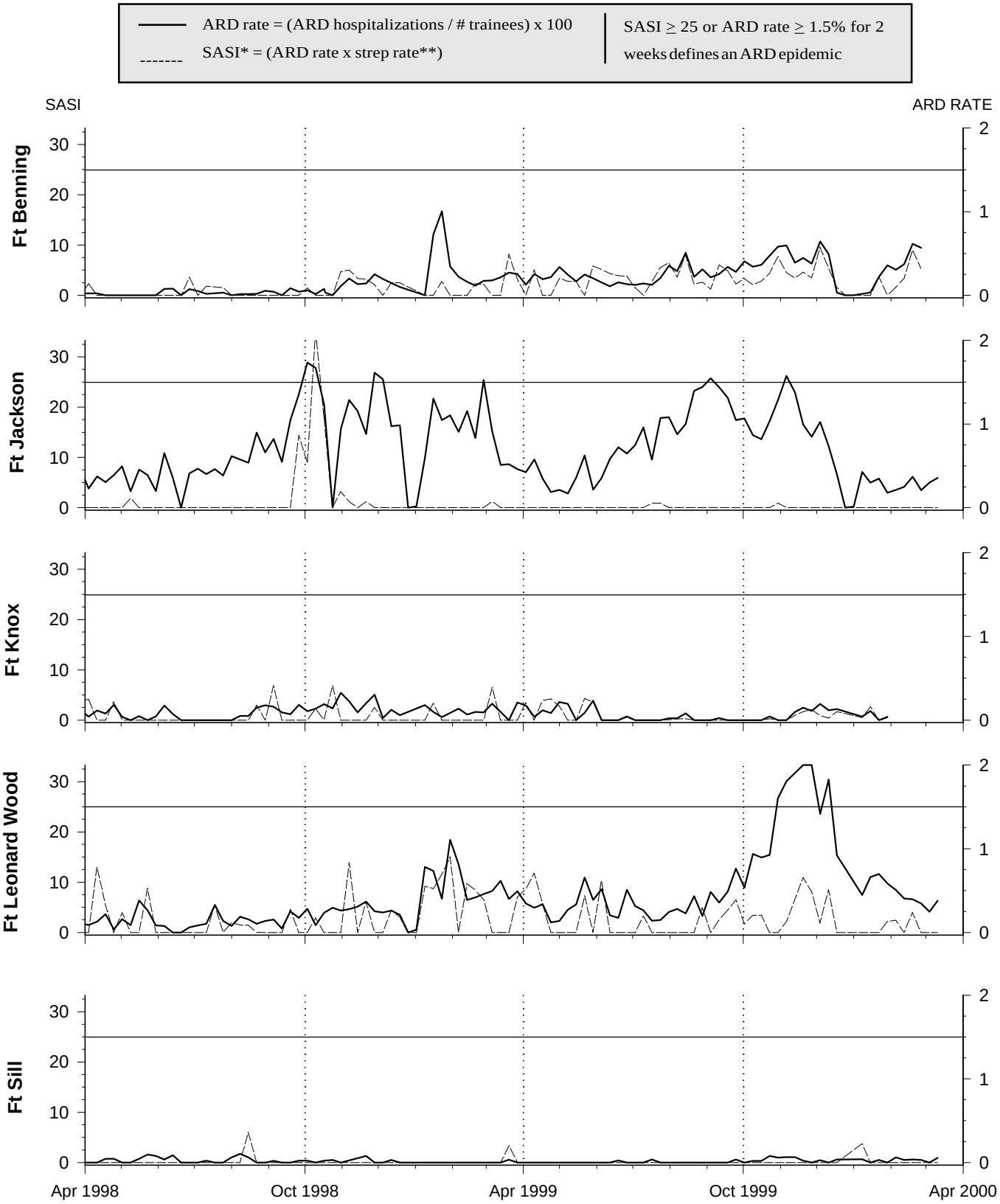
Methods. All data for this study were taken from the Defense Medical Surveillance System. The surveillance population included all who served in an active component of the US Armed Forces during the surveillance period January 1995-September 1999. Hospitalization records and reports of confirmed cases in the Army Reportable Medical Events System were searched to identify those with primary diagnoses of arthropod-borne diseases, such as malaria (International Classification of Diseases,

Table 1. Anthropod-borne diseases, by demographic characteristics, US Armed Forces, 1995-1999[1]

Characteristics	Dengue Fever		Leishmaniasis		Lyme disease		Malaria		Rocky Mountain Spotted Fever	
	N	Rate[2]	N	Rate[2]	N	Rate[2]	N	Rate[2]	N	Rate[2]
All	20	0.3	81	1.1	79	1.1	286	3.9	20	0.3
Gender										
Women	1	0.1	-	-	17	1.7	8	0.8	-	-
Men	19	0.3	81	1.3	62	1.0	278	4.4	20	0.3
Age										
17 - 24	3	0.1	45	1.6	25	0.9	117	4.2	10	0.4
25 - 34	11	0.4	29	1.0	35	1.2	114	4.0	8	0.3
35 - 65	6	0.4	7	0.4	19	1.1	55	3.2	2	0.1
Race/ethnicity										
Asian/Pacific Islander	2	0.8	3	1.2	3	1.2	19	7.4	-	-
Black	1	0.1	11	0.8	16	1.1	47	3.3	3	0.2
Hispanic	3	0.5	2	0.4	4	0.7	22	4.0	-	-
White	13	0.3	61	1.3	52	1.1	193	4.0	17	0.3
Other/unknown	1	0.8	4	2.4	4	3.2	5	3.9	-	-
Service										
Air Force	-	-	1	0.1	4	0.2	18	1.0	3	0.2
Army	13	0.5	71	2.9	59	2.4	238	9.7	9	0.4
Marine Corps	-	-	5	0.6	11	1.3	11	1.3	6	0.7
Navy	7	0.3	4	0.2	5	0.2	19	0.9	2	0.1
Grade										
Junior enlisted (E1-E4)	4	0.1	52	1.6	33	1.0	153	4.7	14	0.4
Senior enlisted (E5-E9)	14	0.5	22	0.8	24	0.8	101	3.5	6	0.2
Officer	2	0.2	7	0.6	22	1.9	32	2.7	-	-
Occupation[3]										
Administrators/support	1	0.1	2	0.2	10	0.9	24	2.1	-	-
Healthcare	1	0.2	4	0.7	12	2.0	20	3.4	3	0.5
Tactical officers/infantry	11	0.7	60	3.6	13	0.8	119	7.1	6	0.4
Service officers/handlers	-	-	2	0.3	11	1.9	27	4.7	3	0.5
Other	7	0.2	13	0.4	33	1.0	96	2.9	8	0.2

1. Through September 30, 1999.
2. Cases per 100,000 person-years.
3. IAW DoD Occupational Conversion Index.

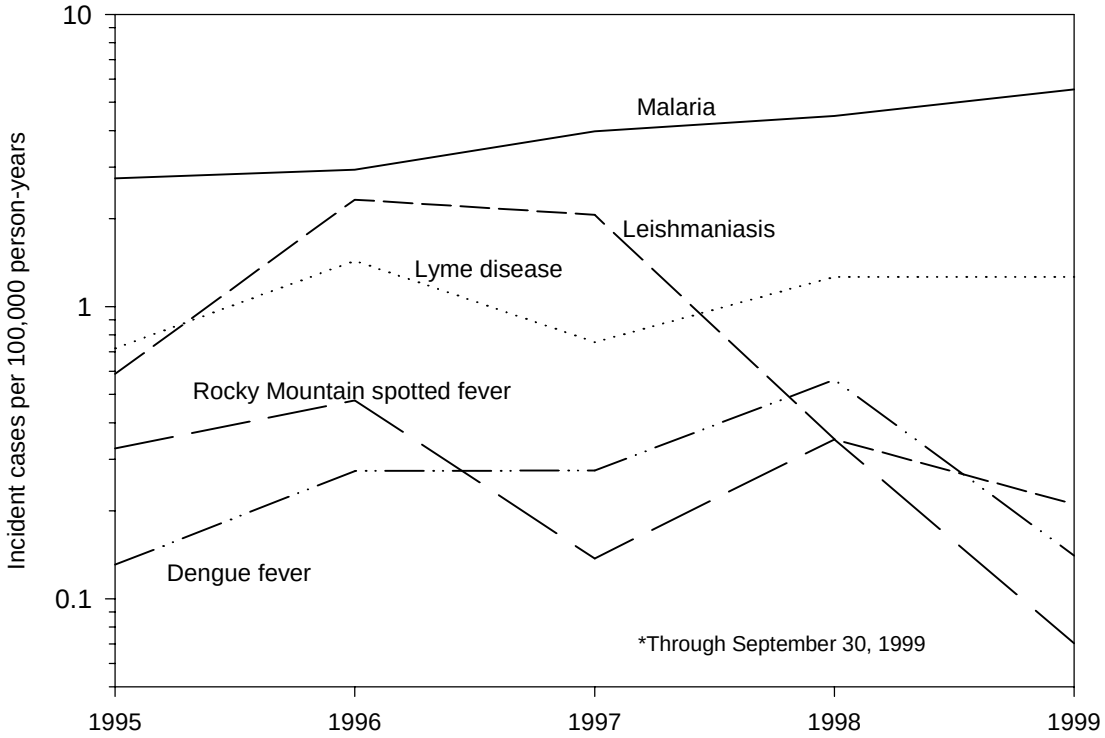
Figure II. Acute respiratory disease (ARD) surveillance update
US Army initial entry training centers



* SASI (Strep ARD Surveillance Index) is a reliable predictor of serious strep-related morbidity

** Strep rate = (Group A beta-hemolytic strep(+) / # cultures) x 100

Figure 1. Annual trends in arthropod-borne diseases, US Armed Forces, 1995-1999*



9th revision, Clinical Modification [ICD-9-CM] code: 084.0-084.9); leishmaniasis (ICD-9-CM code: 085.0-085.9); Lyme disease (ICD-9-CM code: 088.81); dengue fever (ICD-9-CM code: 061); or Rocky Mountain spotted fever (ICD-9-CM code: 082.0). If an individual had multiple hospitalizations or case reports for the same disease, only the first event was included for analysis.

Results, general. For the five-year surveillance period, there were 540 cases of arthropod-borne diseases in the US Armed Forces. The overall incidence rate was 7.4 per 100,000 person-years. The most common disease was malaria (n=286, 53% of all cases), followed by leishmaniasis (n=81, 15%), Lyme disease (n=79, 15%), dengue fever (n=20, 4%), and Rocky Mountain spotted fever (n=20, 4%). All other arthropod-borne diseases accounted for the remaining 9% of cases.

Demographic correlates of risk. For arthropod-borne diseases in general (and for malaria, dengue, leishmaniasis, and RMSF, separately), those at highest risk were young enlisted men in the "infantry/gun crews/seaman" occupational category (table 1, page 12). For Lyme disease, however, women had higher risk than men, officers had nearly twice the risk of enlisted personnel, and medical and service/supply workers had higher risks than others.

Trends. Arthropod-borne disease rates overall increased by approximately 13% during the surveillance period (figure 1). Malaria incidence rates increased each year of the period and approximately doubled from the first year to the last. Leishmaniasis incidence declined precipitously in 1997-1999 (coincident with the curtailment of training in, and the withdrawal of US forces from, Panama). Rates of Lyme disease, RMSF, and dengue fever varied from year to year without clear overall trends.

Locations of diagnoses/treatment. In general, arthropod-borne diseases were most often diagnosed at medical facilities in the southeastern United States (table 2). Notably, however, more malaria cases were diagnosed in Korea (n=75, 26%) than in any other location; approximately one-third (n=26, 32%)

Table 2. Arthropod-borne diseases, by location of diagnosis/treatment, US Armed Forces, 1995-1999[1]

Treatment facility locations	Dengue Fever	Leishmaniasis	Lyme disease	Malaria	Rocky Mountain Spotted Fever
Total	20	81	79	286	20
United States					
Northeast	-	3	7	34	1
Southeast	11	40	34	59	13
North Central	-	-	-	3	-
South Central	-	1	9	30	4
Northwest	4	5	1	11	-
Southwest	-	2	3	11	1
Germany	-	-	21	14	-
Japan	-	-	-	3	-
Korea	-	-	2	75	-
Pacific Islands	1	-	-	27	-
Panama	-	26	-	5	-
Ships	4	4	2	14	1

1. Through September 30, 1999

of all leishmaniasis cases were diagnosed in Panama; and approximately one-fourth (n=21, 27%) of all Lyme disease cases were diagnosed in Germany.

Editorial comment. Military service is inherently risky in regard to arthropod-borne diseases. Servicemembers often deploy to, or reside in, areas where arthropod-borne diseases are endemic; they routinely train, recreate, or conduct operations outdoors in arthropod infested environments; and in the post-cold war era, they deploy overseas to high-risk areas more often. In turn, arthropod-borne diseases remain significant potential threats to the health and operational effectiveness of US forces.

Nearly all tropical arthropod-borne diseases that are diagnosed in the United States are acquired overseas (i.e., there is little or no indigenous transmission).[1-3,5-9,12,13] It is not surprising, therefore, that rates of tropical arthropod-borne diseases are consistently higher in military than in US civilian populations, while rates of temperate arthropod-borne diseases, such as Lyme disease, are lower in US servicemembers than in their civilian counterparts.[14]

In the past five years, rates of arthropod-borne diseases have increased in the US military. The increase overall, however, is most likely attributable to better case ascertainment and reporting and to increasing rates of malaria. In the past few years among soldiers, the majority of malaria infections were acquired in Korea. Prevention, diagnosis, and treatment programs have been developed to counter the threat of malaria of Korean origin.

For each of the most common arthropod-borne diseases (except Lyme disease), male junior enlisted servicemembers with combat-specific occupations were at highest risk. This is not surprising since these servicemembers are most likely to perform occupationally related activities outdoors in arthropod-infested environments. In contrast, females and servicemembers in medical and supply/service support occupations were at highest risk of Lyme disease. This finding suggests that Lyme disease is frequently acquired during off-duty activities and/or that medical and service/support personnel are relatively more likely to have clinically suspected cases reported and/or confirmed through serologic assays.[15-16]

The arthropod-borne diseases discussed in this report are transmitted by different species of arthropods with different ranges, habitats, preferred hosts, and biting behaviors.[3,17,18] Thus, an efficient way to prevent arthropod-related diseases in general

is to avoid arthropod bites of all types. In 1990-91, the US Armed Forces implemented a personal protective measures (PPM) system that included topical application of military-issue 33% extended-duration DEET (N,N-diethyl-m-toluamide) repellent, treatment of field uniforms with permethrin insecticide, and proper wear of field uniforms.[19] When operational circumstances permit, bed nets and tents, especially when treated with insecticides, also are indicated. The US military's PPM system is highly effective when consistently and properly used. However, education, training, and chain of command emphasis are required to assure PPM compliance and health protection.[20]

Data analysis and report by Abigail L. Garvey, MPH, Analysis Group, Army Medical Surveillance Activity.

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Surveillance Trends

Envenomations of Active Duty Soldiers, October 1997-September 1999

Envenomation is the introduction of toxin into the body by the bite or sting of, for example, a snake, scorpion, spider, bee, wasp, or marine animal. Military training and operations often involve prolonged exposures to habitats of venomous reptiles, arachnids, and insects.[1-7] Envenomation-related research has generally focused on pathophysiologic mechanisms, new and investigative treatments, and case studies. However, there is relatively little information regarding the epidemiology of envenomations in military and general populations. In this study, envenomation incidence rates among soldiers over a two-year period are summarized in relation to grade, gender, and season.

Methods. An incident case was defined as an outpatient visit of an active duty soldier for which the primary diagnosis was toxic effects of venom, nonmedicinal (ICD-9-CM code: 989.5). Envenomation-related visits that occurred within 30 days of an index visit were not included.

Exposure to risk was quantified in terms of person-time, which was calculated by summing the periods of service for all active duty Army personnel for the period October 1997 through September 1999. Incidence rates were calculated by dividing the number of incident cases per stratum by the appropriate stratum-specific person-time estimates.

Results. During the two-year surveillance period, there were 2,038 incident outpatient visits for which the primary diagnosis was toxic effects of venom, non-medicinal. The crude envenomation incidence rate was 2.4 per 1,000 person-years. Three-fourths of envenomation cases were among males. Infantrymen (n=408, 20%), health care specialists (n=251, 12.3%), and functional support personnel (n=249, 12.2%) accounted for nearly half of all cases. More cases occurred at Fort Benning, Georgia (n=253, 12.4% of all cases) than any other installation; and of the five installations with the next highest case counts, three were in Texas: Fort Hood (n=173, 8.5%), Fort Sam Houston (n=155, 7.6%), and Fort Bliss (n=104, 5.1%).

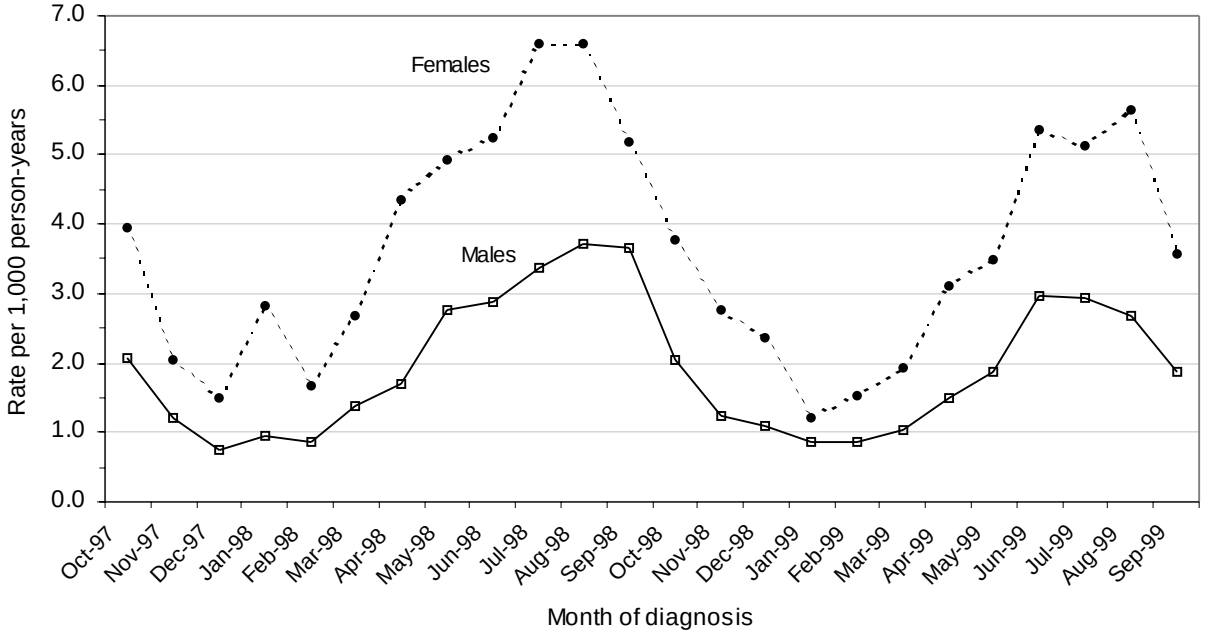
During the surveillance period, females had nearly twice the rate of envenomations of males (4.1 versus 2.1 per 1,000 person years). Soldiers in the lowest enlisted grades (4.1 per 1,000) had higher rates than those who were more senior (table 1). Female soldiers between 25 and 39 years old (4.2

Table 1. Envenomation incidence by gender, age, and grade, active duty soldiers, October 1997-September 1999

Characteristics		Enlisted, PVT (E1-2)		Enlisted, PFC - SGM		Officers, commissioned/ warrant		Total	
Gender	Age	N	Rate[1]	N	Rate[1]	N	Rate[1]	N	Rate[1]
Female	17-24	67	4.6	126	3.4	7	2.9	200	3.7
	25-39	7	4.2	220	4.4	42	3.4	269	4.2
	40-65	0	0.0	19	3.4	16	4.1	35	3.7
							Subtotal (female)	504	4.0
Male	17-24	303	3.9	319	1.7	23	2.2	645	2.3
	25-39	33	4.7	554	1.8	147	1.8	734	1.9
	40-65	0	0.0	57	1.7	98	3.1	155	2.3
							Subtotal (male)	1,534	2.1
Total		410	4.1	1,295	2.1	333	2.4	2,038	2.4

1. Rates are per 1,000 person-years.

Figure 1. Trends of envenomation incidence rates, by gender, active duty soldiers, October 1997-September 1999



per 1,000) had slightly higher rates than those older or younger (each with a rate of 3.7 per 1,000). In contrast, male soldiers between 25 and 39 years old (1.9 per 1,000) had slightly lower rates than those older or younger (each with a rate of 2.3 per 1,000) (table 1, page 17).

Envenomation incidence rates by month are shown in figure 1. In every month during the period, rates were higher among females than males (monthly female-to-male rate ratios, range: 1.39-2.96). Among both females and males, rates were 3.5 to 5 times higher during summer peaks compared to winter troughs. In turn, female-to-male rate differences were greatest during the high risk summer months.

Editorial comment. This analysis documents approximately 1,000 toxic envenomations of soldiers per year that resulted in at least one outpatient clinic visit. Unfortunately, the ambulatory records that were the source of data used for the analysis did not indicate the nature of the envenomations or relationships, if any, to the conduct of military duties.

Peak envenomation rates during summer seasons undoubtedly reflect increased exposures of soldiers (both on and off duty) to the habitats of active, often numerous venomous arthropods, reptiles, and marine life (e.g., jellyfish). In terms of military occupations and grades, infantry soldiers and privates (E-1/E-2) accounted for the largest proportion and highest rates of envenomations, respectively. These findings are understandable given the nature of basic military training in particular and of infantry training and operations in general.

Less understandable, perhaps, is the finding that rates of envenomations were consistently higher among female soldiers than males. It seems unlikely that females were exposed to venomous bites and stings more often in the course of their military duties. Females may be more likely than males to be bitten or stung in or near their residences or during recreational activities; they may have more serious clinical reactions (e.g., allergic) to certain toxins;[8,9] and/or they may be more likely to seek medical care or to have their visits recorded in the military's automated ambulatory data system. Clearly, information regarding envenomations (e.g., prevention, first aid care) should be provided to females and other soldiers not in infantry or other intrinsically "outdoor" military occupations.[10]

Data analysis and report by Scott D. Barnett, PhD, Analysis Group, Army Medical Surveillance Activity.

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